highered and a processing temperature is increased to a high temperature and a silicon source gas is made to flow at a large amount of flow and a halogenide gas is not made to flow and a dopant gas is made to flow at a small amount of flow or is not made to flow at all.

[0179] In this manner, an object of this process is to form an epitaxial film **76**, which is doped with a low concentration of dopant or is not doped, over the bottom and side surfaces of the trenches **61** and hence it is not necessary to fill the epitaxial film **76** completely in the trenches **61**. For this reason, unlike the forming of an epitaxial film by the mixed gas of a silicon source gas and a halogenide gas as shown in the first embodiment, the epitaxial film is formed only by a silicon source gas. Therefore, in the case of forming an epitaxial film by the mixed gas, there is apprehension that a growth rate is reduced by adding a halogenide gas, but since the epitaxial film is formed only by the silicon source gas in this embodiment, the epitaxial film can be formed without the apprehension that a growth rate is reduced. Further, when it is intended to fill the epitaxial film more effectively in the trenches by the mixed gas, the epitaxial film needs to be formed at a low temperature, but when this epitaxial film **76** is formed, the epitaxial film **76** can be formed at a high temperature at a high growth rate.

[0180] Here, in this process (of forming the epitaxial film **76**), the halogenide gas is not made to flow but may be made to flow at an appropriate (small) amount of flow for the purpose of controlling the shape of the epitaxial film **76** in the trenches **61**.

[0181] Then, as shown in **FIG. 25C**, a p^+epitaxial film **77** having a larger mount of mixing of dopant than the amount of mixing of dopant in the epitaxial film **76**, that is, a p^+epitaxial film **77** doped with a high concentration of p type impurities is formed in the p^- or non-doped epitaxial film **76** formed in the trenches **61**, whereby the trenches **61** are completely filled with the p^+epitaxial film **77**. At this time, the p^+epitaxial film **77** is grown in the atmosphere of a low vacuum pressure by using the mixed gas of a silicon source gas and a halogenide gas as gas supplied to the silicon substrate so as to form the epitaxial film. When a continuous process shown in **FIGS. 26A** to **26**E is adopted, the vacuum pressure is made to a low pressure, a processing temperature is made to a low temperature, a silicon source gas is made to flow at a large amount of flow, a halogenide gas is made to flow at a large amount of flow, and a dopant gas is made to flow at a large amount of flow (at a high concentration of dopant).

[0182] In this manner, the doped epitaxial growth is performed by using the mixed gas of a silicon source gas and a halogenide gas in the atmosphere of a low vacuum pressure to form the p^+epitaxial film **77**. Performing the doped epitaxial growth in the atmosphere of a low vacuum pressure prevents the effect of a gas flow distribution to form the epitaxial film in the molecular flow, which result in improving the uniformity of dopant concentration.

[0183] As described by the use of **FIG. 24**, epitaxial growth in the atmosphere of a low vacuum pressure is performed within a pressure range from 1000 Pa to 1×10^{-3} Pa. As a result, a diffusion region having a highly uniform concentration of dopant can be grown in the trenches **61**, whereby the trenches **61** are completely filled with the epitaxial film having no void.

[0184] Thereafter, as shown in **FIG. 25D**, heat treatment is performed following the epitaxial process to diffuse the impurities in the p^- or non-doped epitaxial film **76** to make the epitaxial films **76**, **77** into a p epitaxial layer **78**. When the continuous process shown in **FIGS. 26A** to **26**E is adopted, the vacuum pressure is made to high and a processing temperature is increased to a high temperature and a silicon source gas is not made to flow and a halogenide gas is not made to flow and a dopant gas is not made to flow. With this, a p/n column structure having a highly uniform concentration and void-less structure can be formed.

[0185] In this regard, the heat treatment can be continuously performed by stopping the film forming gas and the dopant gas and by controlling a processing temperature in an epitaxial film forming apparatus. Alternatively, the impurities can be diffused by a thermal oxidization process or a heat treatment process, which is a downstream process, after the silicon substrate is carried out of the epitaxial film forming apparatus. Further, a super-junction device requires for the p/n column structure to the same amount of charges. As shown in **FIG. 25C**, even in a state where the p^- or non-doped epitaxial film **76** remains, when the amount of charge in the n region of the silicon substrate **60** is equal to the amount of charge in the p^+epitaxial film (filled p epitaxial region) **77**, the device can perform a super-junction operation. Therefore, even when the device has a structure not subjected to a heat treatment, the device can perform a desired operation.

[0186] As described above, in this embodiment, the trenches **61** are formed in the silicon substrate **60** and then the epitaxial film **76** is formed over the silicon substrate **60** including the bottom and side surfaces of the trenches **61**. Further, at least at the final step of filling, by using the mixed gas of a silicon source gas and a halogenide gas as the gas supplied to the silicon substrate so as to form the epitaxial film at a lower vacuum pressure of growth than the vacuum pressure of growth when the epitaxial film **76** is formed over the silicon substrate **60** including the bottom and side surfaces of the trenches **61**, the epitaxial film **77**, which is doped with a higher concentration of impurities than the concentration of impurities of the epitaxial film **76** formed over the silicon substrate **60** including the bottom and side surfaces of the trenches **61**, is formed, whereby the trenches **61** are completely filled with the epitaxial film **77**. Hence, by reducing the vacuum pressure to a low pressure when the trenches **61** are completely filled with the epitaxial film **77** doped with impurities by using the mixed gas of a silicon source gas and a halogenide gas, the concentration of impurities can be made uniform (uniformity of the concentration of impurities can be improved). To be more detailed, reducing the vacuum pressure to a low pressure prevents the effect of a gas flow distribution to enable the epitaxial film to grow in the state of molecular flow, which results in improving uniformity of the concentration of impurities. Further, by forming the epitaxial film only by a silicon source gas without using the mixed gas of a silicon source gas and a halogenide gas, a reduction of throughput can be prevented (in **FIG. 25**, when the epitaxial film **76** is formed, a halogenide gas is not mixed, which can prevent a reduction of throughput).

[0187] Further, the vacuum pressure of growth when the epitaxial film **77**, with which the trenches **61** are completely filled, is formed ranges from 1000 Pa to 1×10^{-3} Pa. Hence,